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A REVIEW OF THE NEW ENGLAND LIMPETS[1]

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In my list of New England Mollusca, 1915, I recorded with some misgivings three species of Acmaea. To one collecting extensively for a period of years the question as to the validity of two of these species becomes more and more apparent, notwithstanding the fact that authors have made some anatomical studies of the three forms. *Acmaea testudinalis* (Müll.), was based on European specimens. Dr. Bartsch (1922), on shell characters alone, considers ours a subspecies using the name *amoena,* a name bestowed upon the American form by Say in 1822. When we consider the great variation of the shells in size, form, color, and sculpture, in its range from New York to Labrador, this distinction seems uncalled for, as it is impossible to separate the shells of America from those of Europe. Say gives only the width of his largest specimen which measures 3/10 of an inch. This would indicate a length of about 12 to 14 mm. Jeffreys in 1865 records from Oban and Moray Firth, Scotland, specimens about 30 mm in length.

[1] Read before the Boston Malacological Club, February 7, 1928.

Dr. Pilsbry in 1891 says:—"More than any other shells these must be studied with constant reference not only to habitat geographically, but station as well. For an exact knowledge of the group we must therefore wait until observations on the species are made with special reference to their modes of life and surroundings."

A. testudinalis attains its greatest size in the region about Eastport, Maine. Dr. M. A. Willcox (1905), in her interesting paper on the "Biology of *Acmaea testudinalis*" says: "On the Massachusetts coast a limpet an inch long is a giant but at Eastport they not rarely reach a length of 32 mm. The first explanation of this fact which presents itself is of course that the cooler water presents the optimum temperature for these animals; this is not, however, the only possible explanation. The arctic current is not only cooler but more equable in temperature than more southern waters. At Eastport the maximum yearly variation in temperature of the water is about 12° C. (3.5°—54° F.); at Boston it is nearly 23° C. (29°—70° F.). Limpets living entirely below tide mark would therefore enjoy comparatively equable temperature conditions at Eastport. This would not, however, be true of those living between tide-marks for the annual variation in temperature of the air at Eastport is often as much as 4°—67° F. in a single month. Bathed twice a day by the water, exposed twice a day to the air, such individuals in spite of the comparatively cool places they affect, would be exposed to conditions probably at least as variable as those of the Massachusetts waters. If now we examine their size with reference to their habitat, we find that the limpets of Eastport are large only when living at or near low-water mark of spring tides so that they are rarely or never uncovered by the sea, and that higher up on the rocks the animals though no less abundant are of smaller size, no larger in fact than with us. We find that in Massachusetts there is no marked difference in size between limpets which are continuously submerged and those which live between tide-marks. The conclusion is therefore forced upon us that size in these animals is corre-

lated not necessarily with a low but with an equable temperature."

In this connection I might state that in a series of 30 specimens from Eastport in the collection of the Boston Society of Natural History there are three that measure 47, 43, and 41 mm. in length and 36, 33, and 30 mm. in width. Having thus ascertained the locality and the apparent conditions under which the species attains its greatest size, a study of the species northward from Eastport presents the following variations in size. In a series of 44 specimens from Digby, Nova Scotia, the largest measured 29 mm. In 33 from the west coast of Newfoundland, the largest is 26 mm., while from Labrador the largest is 19 mm. I do not know under what conditions the Digby specimens were taken but those further north are no doubt affected by the much colder conditions.

Going southward from Eastport, we find that in a series of 31 collected at Bar Harbor, Me., the largest measures 38 mm. In a series of 66 specimens from Bass Rocks, (East Gloucester), Castle Rock, Marblehead Neck, and Nahant, Mass., the largest measuring 29 mm. was taken in 20 fathoms off Nahant, while the largest from the rocks at low-tide measures 26 mm. In a series of 80 from Castle Island, Boston Harbor, collected by W. J. Clench and P. S. Remington Jr., in 1915, the largest measures only 18 mm. In a collection of 74 specimens from South Cohasset, Mass., made by Dr. H. Bryant about 1867, the largest measures 27 mm. The shells from the latter place are exceedingly variable averaging about 20 mm. in length, many having the same form and convexity as those from Long Island Sound.

South of Cohasset the gravelly and sandy shores of the Cape Cod section present unfavorable conditions for limpets. From Woods Hole westward along the shores of Long Island Sound where rocky conditions predominate, is found a small form which was named by Wheat in 1913 *Acmaea fergusoni*. He says: "Compared with *A. testudinalis* the shell is smaller, more convex, less elongate and less

variable in form." His two largest specimens have a length of 20 and 19 mm. and each a width of 16 mm. "the average convexity is approximately one-third greater than for *testudinalis*." The radula as figured by Wheat shows considerable variation even in the different rows of the teeth in the same individual. A proper comparison would be with those of a corresponding size, say from Cohasset rather than with those from Maine. Six specimens from Hemstead Bay, N. Y., are mottled with brown like the typical *testudinalis*, the largest being 19 mm. in length and 10 mm. in width. The most interesting series of this form consists of 27 specimens collected in 1920 by Miss E. C. Comstock, at Westbrook, Conn. The largest is 20 mm long and 11 mm. wide. Many have a pink or bluish tinge, with the brown markings obselete or wanting.

With the inequality of temperature of both air and water more marked than even on the Massachusetts coast north of Cape Cod, with weaker tides, currents and waves in the more land locked waters and the water probably less saline, one would naturally expect a marked change in a species living under what are apparently more unfavorable conditions.

Now as to the standing of *Acmaea alveus* Conrad (1831). In collecting on the rocks of the New England coast for the past 25 years I have failed to find a specimen of *alveus* associated with *testudinalis*, although other collectors have recorded it from rocks. Gould in 1841 says: "Found abundantly on eel-grass (*Zostera marina*) to whose narrow leaves its form is exactly adapted." Further on Gould says: "This shell is the very miniature of *Patella compressa*. Mr. Sowerby suggests that it bears the same relation to *A. testudinalis* as *P. compressa* does to *miniata;* in other words it is the same species changed in form from having adhered to a narrow sea-weed instead of a stone." Couthouy in 1839 says: "I have never found *alveus* except upon marine plants." Verrill in 1873 says: "A peculiar narrow form of this shell (var. *alveus*) lives on the leaves of eel-grass." Pilsbry in 1891 says: "Numerous trans-

itions occur between this and the typical *testudinalis*. The narrow form is caused by residence of individuals on seaweed or *Zostera* fronds." Whiteaves in 1907 says: "Specimens of the var. *alveus* (a narrow variety, formed as Dall says, by the 'residence of the individual on a narrow frond of seaweed or *Zostera*') have been found by the writer at low-water in Shediac Bay." [New Brunswick].

On the other hand Stimpson in 1851 under *alveus* says: "Whole coast. At Bird Island, in Boston Harbor, this species occurs abundantly upon stones and shells, still retaining its character; which is sufficient to show that it is not a variety of the last." [*testudinalis*]. Mr. Dwight Blaney (1904,) who found *alveus* at Frenchmans Bay, Me., says: "A few found under beach stones; reported common on eel grass." In 1907 Henry Jackson, Jr. recorded *alveus* at North Haven, Me., as "most commonly found on eel grass which grows in great profusion." He also states that "this narrow compressed form of *alveus* it would seem might have been caused by its being on eel grass which has narrow leaves and might cause a shell to be narrow by lack of space." He made a study of the radulae of the two forms, based on 15 *testudinalis* and 30 *alveus*. Figure 1, plate 2, represents a portion of the radula, the part not mentioned. No variation was observed in the 15 specimens but among the 30 specimens of *alveus* there was considerable variation. We wonder whether the radula of a young *testudinalis* corresponding in size to that of *alveus* would differ as much? We think not, for while the variation of the radula in *alveus* indicates probably immaturity, the number of abnormal radulae in the 30 specimens shows that we are probably dealing with a variety due to habitat and not a valid species.

In 1910 Prof. Edward S. Morse published an interesting paper on "An early stage of *Acmaea*", in which he states that: "I have not yet succeeded in finding the young of *A. alveus* before losing its embryo shell. The cicatrix on the apex of the smaller specimens of *A. alveus* resembles so closely a similar cicatrix on the young of *A. testudinalis* that I am convinced the embryo shell must be identical in the two

species." Further on he says: "In this paper I have dealt with *A. testudinalis* and *A. alveus* as distinct species. At the outset I began the work solely for the purpose of determining the specific value of *A. alveus* and the propriety of its separation from *A. testudinalis*. By the earlier student, the two species were regarded as distinct, but later Tryon, Verrill, Dall and others had come to regard *A. alveus* as only a variety of *A. testudinalis*." * * "So far as I have observed, *testudinalis* occurs in pools at low tide exposed to dashing waves. I have never seen a specimen of this species on eel grass: *alveus* on the contrary lives on eel grass in quiet water and in certain places hundreds may be collected in a short time. It was naturally believed by some observers that the long narrow form of *alveus* had become so by adaptation to its narrow resting place; if so, it is a good example of a species in the process of establishing itself. Whatever may be the case the specific characters are now so firmly fixed that I have never seen a specimen, young or old that the difference between them could not be told at a glance."

"In studying *alveus* alive it is found to move freely on the eel grass, swinging its head from side to side, its tentacles projecting far beyond the lateral edge of the shell: *testudinalis*, on the contrary remains fixed for hours and only in the extreme young have I seen considerable freedom of motion Mr. Dwight Blaney has found *alveus* on the under side of stones on a coarse pebbly beach at Ironbound Island, Maine, and I have observed it in similar situations in Salem Harbor, Mass. In both these instances, however, the creature might have become detached from its usual resting place on eel grass by storms and washed by waves to these unaccustomed places."

To briefly recapitulate, nearly all concede that the true home of *alveus* is on eel grass, and that its occurrence on pebbles and stones (not rock) probably represents an infrequent shift of habitat. Eel grass is a perennial, the creeping stems living throughout the winter, the young leaves appearing in June and disappearing with the autumnal

storms. What becomes of the millions upon millions of *alveus?* Swept ashore on the eel grass they are destroyed and there is not enough of them left to reproduce the millions that will appear on the next season's growth of eel grass. Then where does *alveus* come from? When *testudinalis* spawns in the summer the slimy rocks present comparatively few suitable places for the embryos to attach themselves. On the other hand the young, clean leaves of the eel grass offer an ideal surface for attachment, thus we find that in the vicinity of rocks, the leaves are usually covered with young shells, and when no rocks are near the shells are usually wanting. The young are therefore evidently all *testudinalis,* assuming the form of *alveus* when they attain a size that is affected by the narrow leaves of the eel grass. There is also little doubt, that, when *alveus* reaches maturity its young would be *testudinalis,* these depending upon eel grass to assume the form of the parent.

Dr. Willcox in her paper above referred to says: "The breeding season appears to be a long one. I have taken ripe limpets near Boston as early as the thirteenth of April and as late as the end of July. In Eastport they were still laying during the first week in September. In each place the generative season probably ends a little before the water reaches its maximum heat, which occurs at Eastport in September, at Boston in August. Thus all of a lot of specimens from Nahant in the middle of August had the generative gland empty and the same was true of a considerable part of those gathered at Eastport during the first few days of September. Sexual maturity is probably acquired after the first winter, as I have taken ripe limpets in April which were under a cm. in length."

Conrad's figure which is natural size measures 13 mm. The largest specimen of *alveus* in a series of 14 from Isleboro, Me., is 14 mm. and in a series of 18 from Revere, Mass., the largest is 15 mm., the average size being about 12 mm. There is in the Society's collection a specimen marked "Mass." collected by Couthouy that measures 21

mm. This may be one that had moved from the eel grass to a rock and represents a second year's growth. This brings up a question. Are the specimens that grow on eel grass capable of standing a life on rocks? The muscles of the foot of those growing on the flexible eel grass could not possibly be as strong as those growing on a firm rock while the thinner, narrower, and more elevated shell would also make them more susceptible to their enemies. Thus the inability of *alveus* to adapt itself to a different station than eel grass probably accounts for the absence or scarcity of large specimens of *alveus*. It seems strange that no one has apparently taken a specimen 21 mm. in length since the days of Captain Couthouy. Professor Morse refers to the living *alveus* as moving freely and swinging its head from side to side. Why is it so restless? Is it an acquired motion, due to the undulations of the eel grass in the waves and tides, or is it possible that *alveus* realizes it has made the mistake of its young life in attaching its shells to eel grass instead of a rock?

This paper is written to show that there is still a great deal of work to be done on the biology of this interesting limpet, and also to emphasize the importance of recording the exact conditions under which the shells were collected. Not only the exact locality but the very rocks on which they were taken should be considered, also whether the shells were found above or below low water mark. If dredged the depth should always be recorded. When collected on eel grass the location of the grass in relation to rocks should be noted, and above all the time of the year the specimens were taken. Note the time of the first appearance of shells on eel grass. Some clean rocks should be placed in the grass and the growth of the young shells on the rocks, compared carefully with those on the eel grass.

Oil and harbor pollution is sadly affecting many of the old collecting grounds. It is very doubtful if Clench and Remington could duplicate their collection made at Castle Island in 1915. Miss Comstock in 1920 complained of the

limpets being destroyed by the oil that settled on the rocks at low tide at Westbrook, Conn. Conditions are not improving and the necessity for careful records as to the present status of our fauna becomes more and more urgent.

Bibliography

1822. T. Say. Journ. Acad. Nat. Sci. Phila., vol. II, p. 223.
1831. T. A. Conrad. Journ. Acad. Nat. Sci. Phila., vol. VI, p. 367, pl. XI, f. 20.
1839. J. P. Couthouy. Boston Journ. Nat. Hist., vol. 2, p. 177.
1841. A. A. Gould, Invertebrata of Mass., p. 154.
1851. W. Stimpson. Testaceous Mollusks of N. England, p. 30.
1865. J. W. Jeffreys, Brit. Conch., vol. III, p. 246.
1870. A. A. Gould and W. G. Binney. Invert. Mass., p. 269.
1873. A. E. Verrill. Invert. Animals, Vineyard Sound, p. 307.
1891. H. A. Pilsbry. Manual Conch., vol. 13, 1 ser., pp. 8 and 11.
1901. J. F. Whiteaves. Cat'l Marine Invert. E. Canada, p. 156.
1904. D. Blaney. Proc. Boston Soc. Nat. Hist., vol. 32, p. 37.
1905. M. A. Willcox. Amer. Nat., vol. 39, pp. 326 and 331.
1907. H. Jackson, Jr. The Nautilus, vol. 21, p. 1-2, pl. 2.
1910. E. S. Morse. Proc. Boston Soc. Nat. Hist., vol. 39, pp. 316 and 321.
1913. S. C. Wheat. Mus. Brooklyn Inst. Arts & Sci., Science Bull., vol. 2, p. 17-20, pl. 1.
1915. C. W. Johnson. Boston Soc. Nat. Hist., Occas. Papers, no. 13, p. 85.
1922. Paul Bartsch. The Nautilus, vol. 35, p. 86.